TABLE 8.—*Values of the heat of formation, $\Delta Hf°$, free energy of formation, $\Delta Ff°$, logarithm of the equilibrium constant of formation, $\log_{10}Kf$, and the equilibrium constant of formation, Kf, of H_2O (gas), CO (gas), CO_2 (gas) and CH_4 (gas), from the elements in their standard states*

Reaction	Temperature in degrees Kelvin														
	0	298.16	300	400	500	600	700	800	900	1,000	1,100	1,200	1,300	1,400	1,500
	Heat of formation, $\Delta Hf°$, in kilocalories per mole														
$H_2(gas)+1/2O_2(gas)=H_2O(gas)$	−57.1043	−57.7979	−57.8022	−58.042	−58.276	−58.499	−58.709	−58.902	−59.080	−59.239	−59.384	−59.511	−59.623	−59.724	−59.811
$C(solid, graphite)+1/2O_2(gas)=CO(gas)$	−27.2019	−26.4157	−26.4131	−26.317	−26.295	−26.330	−26.407	−26.511	−26.635	−26.768	−26.909	−27.056	−27.212	−27.376	−27.545
$C(solid, graphite)+O_2(gas)=CO_2(gas)$	−93.9686	−94.0518	−94.0520	−94.069	−94.091	−94.123	−94.167	−94.215	−94.268	−94.318	−94.364	−94.410	−94.456	−94.505	−94.555
$C(solid, graphite)+2H_2(gas)=CH_4(gas)$	−15.987	−17.889	−17.903	−18.629	−19.302	−19.893	−20.401	−20.823	−21.166	−21.43	−21.65	−21.79	−21.92	−22.00	−22.06
	Free energy of formation, $\Delta Ff°$, in kilocalories per mole														
$H_2(gas)+1/2O_2(gas)=H_2O(gas)$	−57.1043	−54.6351	−54.6152	−53.516	−52.358	−51.154	−49.912	−48.643	−47.349	−46.036	−44.710	−43.370	−42.017	−40.661	−39.296
$C(solid, graphite)+1/2O_2(gas)=CO(gas)$	−27.2019	−32.8079	−32.8464	−35.007	−37.184	−39.358	−41.526	−43.677	−45.816	−47.942	−50.053	−52.153	−54.235	−56.308	−58.370
$C(solid, graphite)+O_2(gas)=CO_2(gas)$	−93.9686	−94.2598	−94.2603	−94.325	−94.392	−94.444	−94.497	−94.539	−94.578	−94.610	−94.637	−94.661	−94.677	−94.690	−94.707
$C(solid, graphite)+2H_2(gas)=CH_4(gas)$	−15.987	−12.140	−12.104	−10.048	−7.840	−5.49	−3.05	−0.55	+2.01	4.61	7.22	9.85	12.50	15.14	17.80
	Logarithm of the equilibrium constant of formation, $\log_{10}Kf$														
$H_2(gas)+1/2O_2(gas)=H_2O(gas)$		40.04695	39.78683	29.23972	22.88551	18.63228	15.58315	13.22846	11.49776	10.06104	8.88300	7.89864	7.06367	6.34747	5.72542
$C(solid, graphite)+1/2O_2(gas)=CO(gas)$		24.04790	23.92845	19.12672	16.25283	14.33621	12.96479	11.93193	11.12559	10.47772	9.94448	9.49826	9.11762	8.78999	8.50449
$C(solid, graphite)+O_2(gas)=CO_2(gas)$		69.09145	68.66801	51.53648	41.25820	34.40107	29.50309	25.82664	22.96647	20.67675	18.80256	17.23998	15.91654	14.78159	13.79863
$C(solid, graphite)+2H_2(gas)=CH_4(gas)$		8.8985	8.8177	5.4899	3.4268	2.0001	0.9526	0.1494	−0.4881	−1.0075	−1.4345	−1.7936	−2.1006	−2.3638	−2.5927
	Equilibrium constant of formation, Kf														
$H_2(gas)+1/2O_2(gas)=H_2O(gas)$		1.114×10^{40}	6.121×10^{39}	1.737×10^{29}	7.683×10^{22}	4.288×10^{18}	3.830×10^{15}	1.943×10^{13}	3.146×10^{11}	1.151×10^{10}	7.638×10^{8}	7.918×10^{7}	1.158×10^{7}	2.226×10^{6}	5.314×10^{5}
$C(solid, graphite)+1/2O_2(gas)=CO(gas)$		1.117×10^{24}	8.481×10^{23}	1.339×10^{19}	1.790×10^{16}	2.169×10^{14}	9.221×10^{12}	8.549×10^{11}	1.335×10^{11}	3.004×10^{10}	8.800×10^{9}	3.150×10^{9}	1.311×10^{9}	6.166×10^{8}	3.195×10^{8}
$C(solid, graphite)+O_2(gas)=CO_2(gas)$		1.234×10^{69}	4.656×10^{68}	3.439×10^{51}	1.812×10^{41}	2.518×10^{34}	3.185×10^{29}	6.709×10^{25}	9.257×10^{22}	4.751×10^{20}	6.347×10^{18}	1.738×10^{17}	8.252×10^{15}	6.040×10^{14}	6.290×10^{13}
$C(solid, graphite)+2H_2(gas)=CH_4(gas)$		7.916×10^{8}	6.572×10^{8}	3.090×10^{5}	2.672×10^{3}	100	8.966	1.411	0.3250	9.829×10^{-2}	3.677×10^{-2}	1.608×10^{-2}	7.932×10^{-3}	4.327×10^{-3}	2.554×10^{-3}

TABLE 11.—*Values of the logarithm of the equilibrium constant, $\log_{10}K$, and the equilibrium constant, K, for some reactions involving O_2, H_2, H_2O, C(graphite), CO, CO_2, and CH_4*

Reaction	Temperature in degrees Kelvin														
	0	298.16	300	400	500	600	700	800	900	1,000	1,100	1,200	1,300	1,400	1,500
	Logarithm of the equilibrium constant, $\log_{10}K$														
$C(solid, graphite)+CO_2(gas)=2CO(gas)$		−20.99575	−20.81089	−13.28281	−8.75242	−5.72851	−3.57358	−1.96284	−0.71538	+0.27865	1.08638	1.75658	2.31863	2.79835	3.21033
$C(solid, graphite)+H_2O(gas)=CO(gas)+H_2(gas)$		−15.99896	−15.85786	−10.11277	−6.65217	−4.29593	−2.61852	−1.35664	−.37226	+.41655	1.06373	1.59959	2.05385	2.44243	2.77906
$CO(gas)+1/2O_2(gas)=CO_2(gas)$		+45.04367	44.73973	32.40960	25.00541	20.06491	16.53817	13.89475	11.84070	10.19920	8.85796	7.74189	6.79887	5.99165	5.29440
$CO(gas)+H_2O(gas)=CO_2(gas)+H_2(gas)$		+ 4.99679	4.95303	3.17004	2.10025	1.43258	0.95506	0.60620	0.34312	0.13790	−0.02484	−0.15699	−0.26478	−0.35592	−0.43127
$CH_4(gas)+1/2O_2(gas)=CO(gas)+2H_2(gas)$		+15.14943	15.11042	13.62866	12.82615	12.33631	12.01203	11.78248	11.61365	11.48514	11.37881	11.29165	11.21808	11.15376	11.09715
$CH_4(gas)+CO_2(gas)=2CO(gas)+2H_2(gas)$		−29.89351	−29.62931	−18.78203	−12.17882	−7.72859	−4.52613	−2.11227	−0.22705	+1.28594	2.52066	3.54995	4.41921	5.16211	5.80289
$CH_4(gas)+H_2O(gas)=CO(gas)+3H_2(gas)$		−24.89745	−24.67628	−15.61144	−10.05889	−6.29601	−3.57077	−1.50580	+.11607	1.42428	2.49602	3.39314	4.15460	4.80634	5.37177
$CH_4(gas)+2H_2O(gas)=CO_2(gas)+4H_2(gas)$		−19.90067	−19.72325	−12.44091	−7.93898	−4.86343	−2.61571	−0.89960	+.45919	1.56218	2.47118	3.23615	3.88982	4.45042	4.94050
	Equilibrium constant, K														
$C(solid, graphite)+CO_2(gas)=2CO(gas)$		1.012×10^{-21}	1.546×10^{-21}	5.214×10^{-14}	1.768×10^{-9}	1.868×10^{-6}	2.669×10^{-4}	1.098×10^{-2}	0.1926	1.900	12.20	57.09	2.083×10^{2}	6.286×10^{2}	1.623×10^{3}
$C(solid, graphite)+H_2O(gas)=CO(gas)+H_2(gas)$		1.002×10^{-16}	1.387×10^{-16}	7.713×10^{-11}	2.228×10^{-7}	5.059×10^{-5}	2.407×10^{-3}	4.399×10^{-2}	.4244	2.609	11.58	39.77	1.135×10^{2}	2.770×10^{2}	6.013×10^{2}
$CO(gas)+1/2O_2(gas)=CO_2(gas)$		1.106×10^{45}	5.492×10^{44}	2.568×10^{32}	1.013×10^{25}	1.161×10^{20}	3.453×10^{16}	7.848×10^{13}	6.930×10^{11}	1.582×10^{10}	7.210×10^{8}	5.519×10^{7}	6.293×10^{6}	9.810×10^{5}	1.970×10^{5}
$CO(gas)+H_2O(gas)=CO_2(gas)+H_2(gas)$		9.926×10^{4}	8.975×10^{4}	1.479×10^{3}	1.260×10^{2}	27.08	9.017	4.038	2.204	1.374	0.9444	0.6966	0.5435	0.4406	0.3704
$CH_4(gas)+1/2O_2(gas)=CO(gas)+2H_2(gas)$		1.411×10^{15}	1.290×10^{15}	4.253×10^{13}	6.710×10^{12}	2.169×10^{12}	1.028×10^{12}	6.060×10^{11}	4.108×10^{11}	3.056×10^{11}	2.392×10^{11}	1.957×10^{11}	1.652×10^{11}	1.425×10^{11}	1.251×10^{11}
$CH_4(gas)+CO_2(gas)=2CO(gas)+2H_2(gas)$		1.278×10^{-30}	2.348×10^{-30}	1.652×10^{-19}	6.625×10^{-13}	1.868×10^{-8}	2.978×10^{-5}	7.722×10^{-3}	0.5929	19.32	3.316×10^{2}	3.548×10^{3}	2.626×10^{4}	1.452×10^{5}	6.352×10^{5}
$CH_4(gas)+H_2O(gas)=CO(gas)+3H_2(gas)$		1.266×10^{-25}	2.107×10^{-25}	2.447×10^{-16}	8.732×10^{-11}	5.058×10^{-7}	2.687×10^{-4}	3.120×10^{-2}	1.306	26.56	3.133×10^{2}	2.473×10^{3}	1.428×10^{4}	6.402×10^{4}	2.354×10^{5}
$CH_4(gas)+2H_2O(gas)=CO_2(gas)+4H_2(gas)$		1.257×10^{-20}	1.891×10^{-20}	3.623×10^{-13}	1.151×10^{-8}	1.369×10^{-5}	2.423×10^{-3}	0.1260	2.879	36.49	2.959×10^{2}	1.723×10^{3}	7.759×10^{3}	2.821×10^{4}	8.720×10^{4}